

**EXHIBIT E****Transtar™****Translucent Polycrystalline Alumina**

Transtar™, translucent polycrystalline alumina, is a recent addition to Ceradyne's growing family of advanced ceramic products. In addition to its excellent optical properties, Transtar™ has the best corrosion resistance and dielectric loss properties of any commercially sintered, commercially available alumina. Ceradyne specializes in custom shapes and can provide metallizing and joining technology.

*Transtar™ Orthodontic Brackets***TRANSTAR'S™ OUTSTANDING PROPERTIES****Microstructure**

Transtar™ is a 99.9 percent pure  $Al_2O_3$  ceramic which is sintered to a nearly full dense, pore-free condition. The high purity and dense microstructure result in superior properties in comparison with other alumina ceramics.

**Optical Transmission**

Curves of total and specular transmission of Transtar™ are shown at the left. Transtar™ is relatively transparent (high specular transmission) at infrared wavelengths in thin walled sections. Total transmission compares favorably with that of sapphire. Due to scattering of light rays by pores, conventional aluminas have poor optical transmission in comparison.

**Corrosion Resistance**

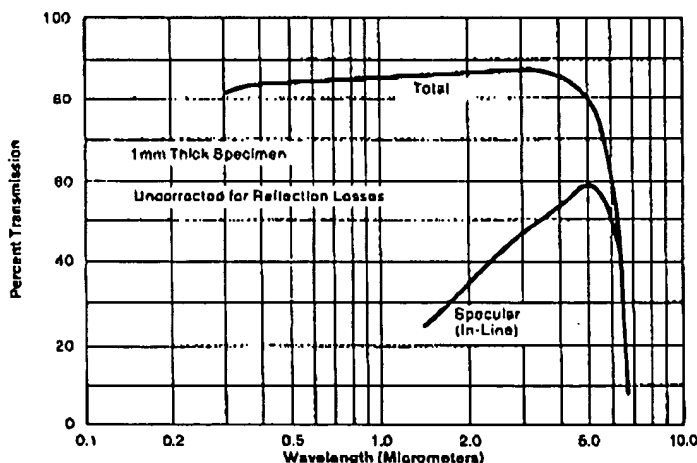
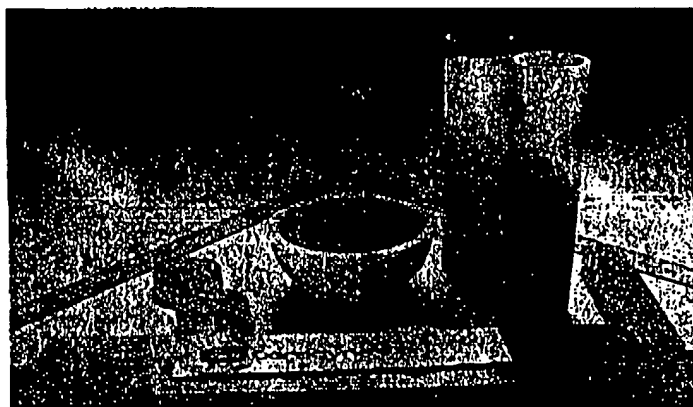
Owing to its high purity and density, Transtar's™ corrosion resistance is comparable to that of sapphire. Transtar™ exhibits no weight loss after days of exposure to boiling acid and alkaline solutions and has excellent resistance to high temperature alkali metal liquids and vapors.

**Thermal Conductivity**

Here again, Transtar™ compares favorable with sapphire owing to its high purity and dense microstructure. Thermal conductivity is on the order of 35 W/K-m at room temperature.

**Electrical Properties**

Electrical properties for Transtar™ approach the theoretical limits for  $Al_2O_3$ . Loss tangent is less than  $10^{-4}$  at frequencies above 1MHz. Dielectric strength exceeds 475 volts per mil for .040-in. thick samples.

*Optical Transmission Curves for Transtar™**Examples of Transtar™ Components*

## Typical Properties of Transtar™

Al <sub>2</sub> O <sub>3</sub> CONTENT	99.9%
DENSITY:	3.99 g/cc
MODULUS OF RUPTURE (Grain Size Dependent)	200-450 MPa 29,000-65,000 Psi
MODULUS OF ELASTICITY	395 GPa 57 X 10 <sup>6</sup> Psi
SHEAR MODULUS	162 GPa 23 X 10 <sup>6</sup> Psi
COMPRESSIVE STRENGTH	3,000 MPa 434,000 Psi
POISSON'S RATIO	0.22
THERMAL EXPANSION COEFFICIENT: RT to 1000°C	8.3 X 10 <sup>-6</sup> /K
THERMAL CONDUCTIVITY @ RT	35 W/mK
SPECIFIC HEAT @ RT	.21 g-cal/gK
ELECTRICAL RESISTIVITY @ RT	> 10 <sup>15</sup> ohm-cm
DIELECTRIC CONSTANT @ RT	10.1
LOSS TANGENT (tan δ) @ RT	< .0001

### Custom Shapes

Ceradyne welcomes both small and large orders for custom shapes and sizes. Extensive green machining and grinding facilities are available.

### Metallizing and Joining

Ceradyne's Ceramic-to-Metal Operation has full capability for metallizing, plating, and brazing Transtar. Available metallizations include conventional Mo-Mn-SiO<sub>2</sub> and alkali vapor resistant W-base compositions.



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Values are typical  
and should not be considered  
as specifications.

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